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June 10, 1986

Dr. Takeshi Yoshihara
Energy Program Administrator
Department of Planning and
Economic Development
335 Merchant Street, Room 110
Honolulu, Hawaii 96813

Dear Dr. Yoshihara:

Subject: Hawaii Deep Water Cable (HDWC) Program Phase II-C

Enclosed are two copies of the preferred route analysis, revised to include DPED and HECO comments in my letter of May 23 to Parsons. Copies have also been provided to DOE for information.

Sincerely,

William A. Bonnet

William A. Bonnet
HDWC Program Manager

WAB:cal
Enclosures
cc: J. Brehany (w/o enclosure)

HDWC PROGRAM

Preferred Route Analysis

May, 1986

INTRODUCTION

The purpose of this paper is to revise the conceptual "preferred route" to reflect information gained in Phase II-B. Using primarily the Overland Transmission Corridor Study, the At-Sea Route Surveys and the old Route Option 2 figure, new maps of the preferred cable route were produced. A revised table displaying the distance and depth characteristics of the new preferred route was also compiled.

GOALS

A goal of the HDWC Program is to demonstrate that at least one technically and economically feasible route option exists for a commercial cable system to follow. This includes cable paths undersea, as well as transmission line corridors overland.

BACKGROUND

The HDWC Program is now in Phase II-C and significant advances have been made in marine cable technology. With the definition of route criteria and constraints, route selections were made. Over forty route alternatives were initially examined during Phase I. Only three route alternatives were chosen to represent the baseline route options. Briefly, Route Option 1 was an all marine route from the northern tip of Hawaii running between Maui and Lanai and south of Molokai to Oahu. Route Option 2 added a shore landing at Maui's southwest end. Route Option 3 proceeded overland on Maui and Molokai. Route Option 2 was considered to be the most feasible route because of the characteristics of the cable selected (oil feed length limitations) and the flexibility built into the system by landing at an intermediate point. New information gathered in Phase II-B makes the present refinement of this route possible. The new "Preferred Route" differs from the old Route Option 2 in several ways. Overland corridors on the Big Island have been more precisely defined, as have potential corridors across the Alenuihaha Channel, but more importantly, the route crosses overland along Maui's southwest coast to avoid a difficult marine segment and maximize the advantages of the Maui landing. The Oahu termination point has been relocated from Makapu'u Point to the Waimanalo Beach area to accommodate overland corridor availability. The entire Preferred Route is described later in this report.

METHODS/TECHNIQUES

The method used to define this route sequence is based on a review of mapped constraints and conditions. Using an overlay technique, potential overland corridors were identified. A review of early HDWC Program studies and more recent Program information enabled further integration of system criteria and route constraints. The Phase II-B at-sea surveys and the overland studies added new information important to the development of potential routes. A comprehensive list of environmental conditions necessary or preferable for a cable system route was compiled and used to re-evaluate the routes previously selected. New route segments are proposed as a result of this analyses.

ASSUMPTIONS

Four assumptions used in revising the preferred route need to be stated. First, the route is a baseline which represents an assessment of an appropriate balance of technical and economic considerations. It is expected that the preferred route will change after more detailed surveys are performed. Second, where overhead transmission line placement does not occur near a convenient road it is assumed that pole installation may take place by either building an access road or by using helicopters to position equipment and workers. Third, it is assumed that where the cable is to be embedded into the shoreline area, a beach or bay region, rather than a cliffed region, will be necessary. Fourth, it is assumed that the corridor width needed along both marine and terrestrial segments of the route can be accommodated.

ENVIRONMENTAL CONDITIONS

Environmental conditions place constraints on cable system siting, installation and operation. Each cable subsystem was designed with knowledge of these constraints. The cable route is divided into four types of areas listed below. The factors considered in selecting routes through each type of area are also listed.

OVERLAND TRANSMISSION LINE CORRIDOR

1. Visual impact can be minimized
2. Minimizes route length
3. Has adequate access to towers for maintenance
4. Land easements of adequate width can be acquired
   (not in path of known future developments)
5. Land costs not too expensive
6. Avoids areas of high winds
7. Avoids residential areas
8. Avoids 'exclusion' areas, such as natural reserve areas
9. Avoids hazardous terrain, such as high slopes and lava tubes

SUBMARINE CABLE CORRIDOR

1. Wide enough for installation and repair of total number of cables in system
2. Follows shallow shelves where possible
3. Not too near shore or anchorage areas
4. Avoids unstable areas
5. Avoids steep slopes and rocky outcrops
6. Avoids paralleling bottom contours
7. Avoids areas of strong currents and moving sediment
8. Avoids 'special' areas, such as Marine Life Conservation Districts and precious coral beds
9. Minimizes route length
10. Has acceptable cable spans and bends

CABLE LANDING SITES

1. Bay or beach area
2. Avoids 'exclusion' areas
3. Can bury the cable, blasting where necessary
4. Not in area of intensive use
5. Land can be acquired for a reasonable cost
6. Adequate access available

SHORESIDE FACILITY SITES

1. Not too far from landing site
2. Adequate access available
3. Visual impact can be minimized
4. Land can be acquired for a reasonable cost
5. Compatable with land use zoning
6. Area can be secured and fenced
7. Avoids 'exclusion' areas

ROUTE DESCRIPTION

Following is a description of the segments comprising the preferred route. The route is graphically depicted in the attached figure.

Segment Number	Segment Description	Segment Type
1H	Puna, East Hawaii to Keaau, East Hawaii	Overland
2H	Keaau to Kawaihae, West Hawaii	Overland
3H	Kawaihae to Mahukona, Northwest Hawaii	Overland
4H	Mahukona to Alenuihaha Channel	Submarine
1A	Alenuihaha Channel width	Submarine
1M	Alenuihaha to Huakini Bay, South Maui	Submarine
2M	Huakini Bay to Ahihi Bay, West Maui	Overland
3M	Ahihi Bay to Waimanalo, East Oahu	Submarine
1O	Waimanalo to Aniani, East Oahu	Overland

The route begins in Hawaii's Puna District where the electricity (ac) is generated from the geothermal resource. Transmission lines from the geothermal plants would traverse north to a point near Keaau and then head northwest to a rectifier station at Kaumana where the alternating current would be transformed into direct current. The dc transmission lines would then follow an existing corridor across the middle of the island. This corridor leads to the Keamuku substation at the top of the North Kona District. The overhead lines would follow a major road north to a point just below Waimea, then turn to the west and follow another major road to the coast at Kawaihae Bay. The lines would travel up the coast, on the inland side of road, from Kawaihae to Mahukona. Just above Mahukona Harbor is Makaohule Point which is the proposed take-off site for the submarine cable. A shoreside facility would be required for transition from overhead lines to submarine cables.

The cables would be embedded across the shoreline and out to water depths of at least 100 feet. The cables would be laid perpendicular to the bottom contours to a depth of about 490 feet and then proceed northward along a terrace towards Upolu Point. They would then proceed northwesterly across the Alenuihaha Channel. The saddle portion of the channel would direct the cable in a relatively straight path toward Maui's southern coast, where the cable would come ashore. Huakini Bay is the preferred landing site and there the cable would again connect to overhead transmission lines. The lines would traverse the southern coast of east Maui to Ahihi Bay.

The longest submarine route segment would begin there. The cables would follow an underwater path to the northwest between Maui, Kahoolawe and Lanai, pass to the south of Molokai, cross the Kaiwi Channel and land on Oahu's eastern shore. The landing point would be near Waimanalo Beach. Offshore there is a natural break in the reef fronting that coast. In Waimanalo the cables would again connect to overhead transmission lines which would extend three miles inland to the Aniani inverter site where the dc power would be converted back to ac power for distribution in Oahu's electrical grid system.

RATIONALE

This route sequence was chosen for many specific reasons. The Big Island overland route follows an existing electrical transmission line right-of-way. Makaohule Point, north of Mahukona was chosen as a preferred entry site into the ocean because it is as far north as possible, yet it has road access and it does not have the steep cliffs characteristic of the shoreline closer to Upolu Point. Offshore there is a flat sandy terrace between Mahukona and the northern tip of the Big Island suitable for the cable to follow before it begins the channel crossing.

The Alenuihaha Channel route was chosen to follow the 'saddle' which is the shallowest area between the Big Island and Maui. On the Hawaii side, the cable may be positioned perpendicular to the bottom contours, but on the Maui side, if a shore landing is not used, the cable would have to parallel the contours, increasing the risk of damage from underwater landslides. To avoid this hazardous area it is proposed to land on Maui's south coast and proceed overland to a point where continuing the submarine route is less hazardous. The area around Huakini Bay was found to be suitable for cable landing and a potential connecting overhead transmission line corridor exists, according to the Overland Transmission Corridor Study. Previously, Waiuha Bay, near Kaupo, was considered the preferred landing point in order to avoid the Kipahulu Forest Reserve Area. However, in the Phase II-B "Overland Transmission Corridor" Study, Waiuha Bay was found to have more "high" constraint factors. Waiuha Bay is about three miles to the east of Huakini Bay. Transmission lines originating there would have to cross through lands rated "high constraint" in cost, land value, and access, plus "medium constraint" in land ownership.

An overland route on Maui would save money in cable costs and avoid a very hazardous marine segment. The lines traversing from Huakini Bay to Ahihi Bay on Maui's west side would be inland rather than along the coast. The area is rural in character and is entirely within the Agricultural Land Use District. Ahihi Bay itself is an area with low geophysical constraints for the cable system. It is on the border of the Moomuku and Kanahena

Districts and does not include the nearby Ahihi-Kinau Natural Area Reserve.

The channels between Maui, Lanai, Molokai and Oahu are shallow and do not place as severe constraints on the cable system as does the Alenuihaha Channel. The submarine cable corridor is positioned near the middle of the channels to avoid activities that take place closer to the shore. However, the corridor is located closer to shore off western Molokai to avoid the Molokai Canyon.

The Oahu landing site was also chosen with the guidance of the Overland Transmission Corridor Study. The Waimanalo landing site would prevent interference with residential lots along the coastline and take advantage of the natural break in the reef. From the Waimanalo landing site the distance is short to Aniani, the inland substation which is the cable system's final destination. This short distance is particularly important as land values are high on Oahu. Fortunately, the area between Waimanalo Beach and Aniani is rural with agricultural land uses.

CONCLUSIONS/FINDINGS

The route described above and shown in the attached figure is based on the best information available to date in the HDWC Program. This Preferred Route does not appear to challenge any of the considerations outlined in the environmental conditions section. However, portions of the overland route encounter environmental/land use factors that may need minor mitigative actions. These factors are listed by island:

Hawaii- slopes and soils, visual, archaeology

Maui- recreation, access, slopes/soils, visual, archaeology

Oahu- urban land use, land values, slopes/soils, visual, archaeology

The first bottom roughness cruise has identified the general level of roughness along the cable route in the Alenuihaha Channel. Many major roughness concerns prior to the cruise, such as the existence of continuous and impassable escarpments or a bottom that is extremely rough everywhere, have been eliminated. The first cruise has therefore greatly increased confidence that an acceptable cable route will can be found across the Channel.

Phase II-C includes more detailed studies and surveys of both overland and undersea route characteristics. These results will be important to the selection of the finalized route option. Possible studies beyond Phase II-C would further evaluate the Preferred Route.

SOURCES

documents:

Environmental Analyses, Phase II-A, Task 1 - 3/84 - (Parsons)

At-Sea Route Surveys, Phase II-B - 11/85 - (HIG)

w/ marine atlas, Appendix A

Overland Transmission Corridor, Phase II-B, Task 5 - 7/85 - (DHM)

Keamana to Keamuku DEIS - 9/83 - (HELCO)

Preliminary Route Survey Analyses - 4/82 - (Parsons)

Plan for Second Bottom Roughness Survey Cruise - 1/86 - (HC&D)

Characterization of Potential Routes and Route Option Selection - 5/85 - (Parsons)

At-Sea Route Surveys, Phase II - 12/83 - (HIG)

Manned Submersible Observations - 11/85 - (HURL)

Kahauale'a REIS - 6/82 - (True/Mid Pacific Geothermal Ventures)

maps:

NOAA Nautical Chart #19340 Hawaii to Oahu

DISTANCE AND DEPTH CHARACTERISTICS OF PREFERRED ROUTE, April, 86

Hawaii to Maui to Oahu

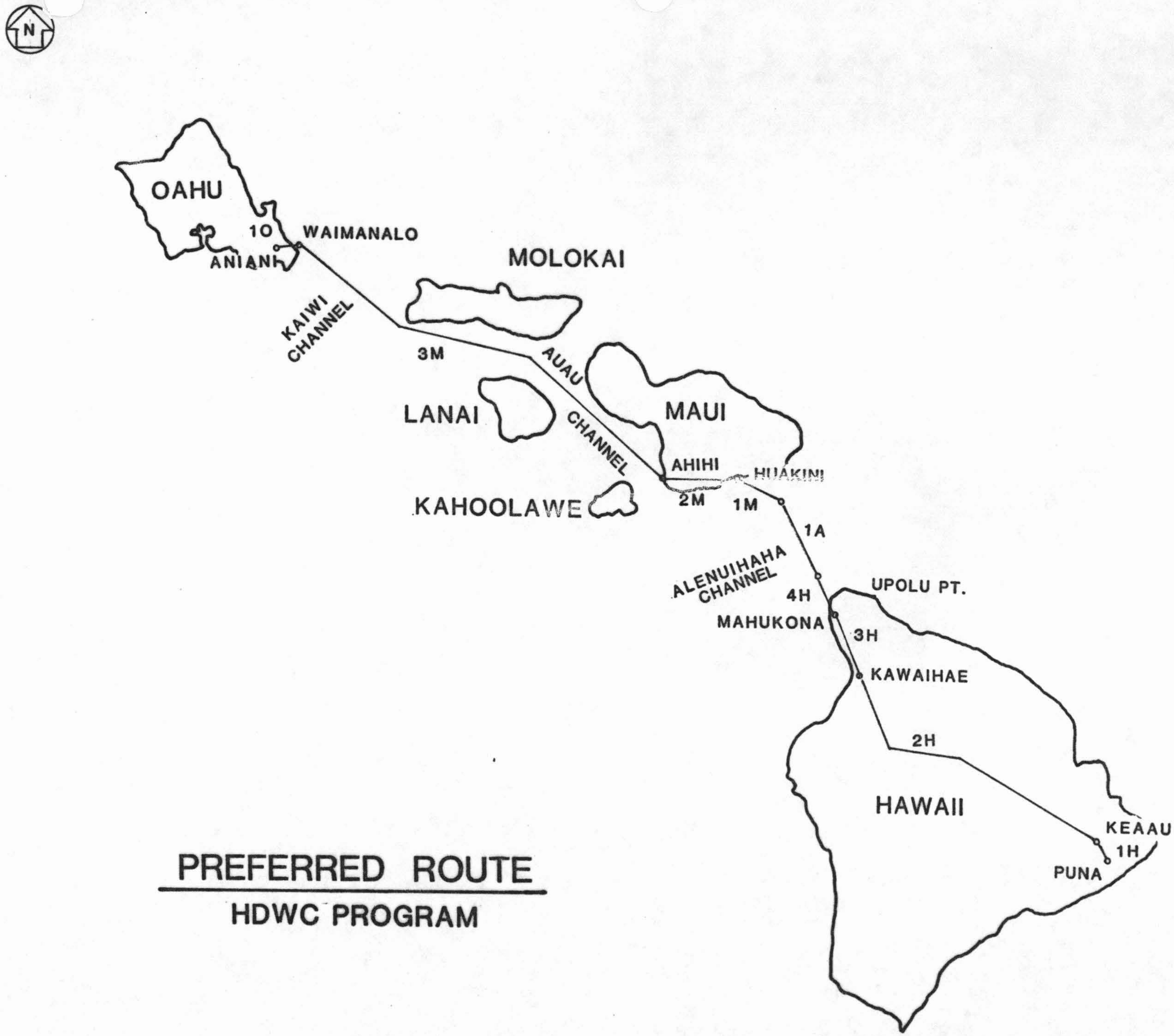
FROM	TO	SEGMENT	OH/SUB	LENGTH KM	LENGTH MI
Puna	Keaau	1H	OH	23	14
Keaau	Kawaihae	2H	OH	129	80
Kawaihae	Mahukona	3H	OH	23	14
Mahukona	Alenuihaha	4H	SUB	32	20
Alenuihaha	Alenuihaha	1A	SUB	19	12
Alenuihaha	Huakini Bay	1M	SUB	16	10
Huakini Bay	Ahihi Bay	2M	OH	32	20
Ahihi Bay	Waimanalo	3M	SUB	154	96
Waimanalo	Aniani	1O	OH	5	3
		TOTAL OVERHEAD		212	131
		TOTAL SUBMARINE		221	138

PERCENTAGE SUBMARINE = 51%

LONGEST SUBMARINE RUN = 154 km

APPROXIMATE DISTANCE WITHIN DEPTH RANGES FOR SUBMARINE PORTIONS (KM)

SEGMENT	DEPTH 0-1800 Feet / 0-547 Meters / 0-300 Fathoms	1800-3600 Feet / 547-1094 Meters / 300-600 Fathoms	3600-5400 Feet / 1094-1641 Meters / 600-900 Fathoms	5400-7200 Feet / 1641-2188 Meters / 900-1200 Fathoms
4H	27	5	-	-
1A	-	10	1	8
1M	7	2	7	-
3M	144	10	-	-
TOTAL	178	27	8	8
PERCENT	80.5%	12.2%	3.62%	3.62%



PREFERRED ROUTE

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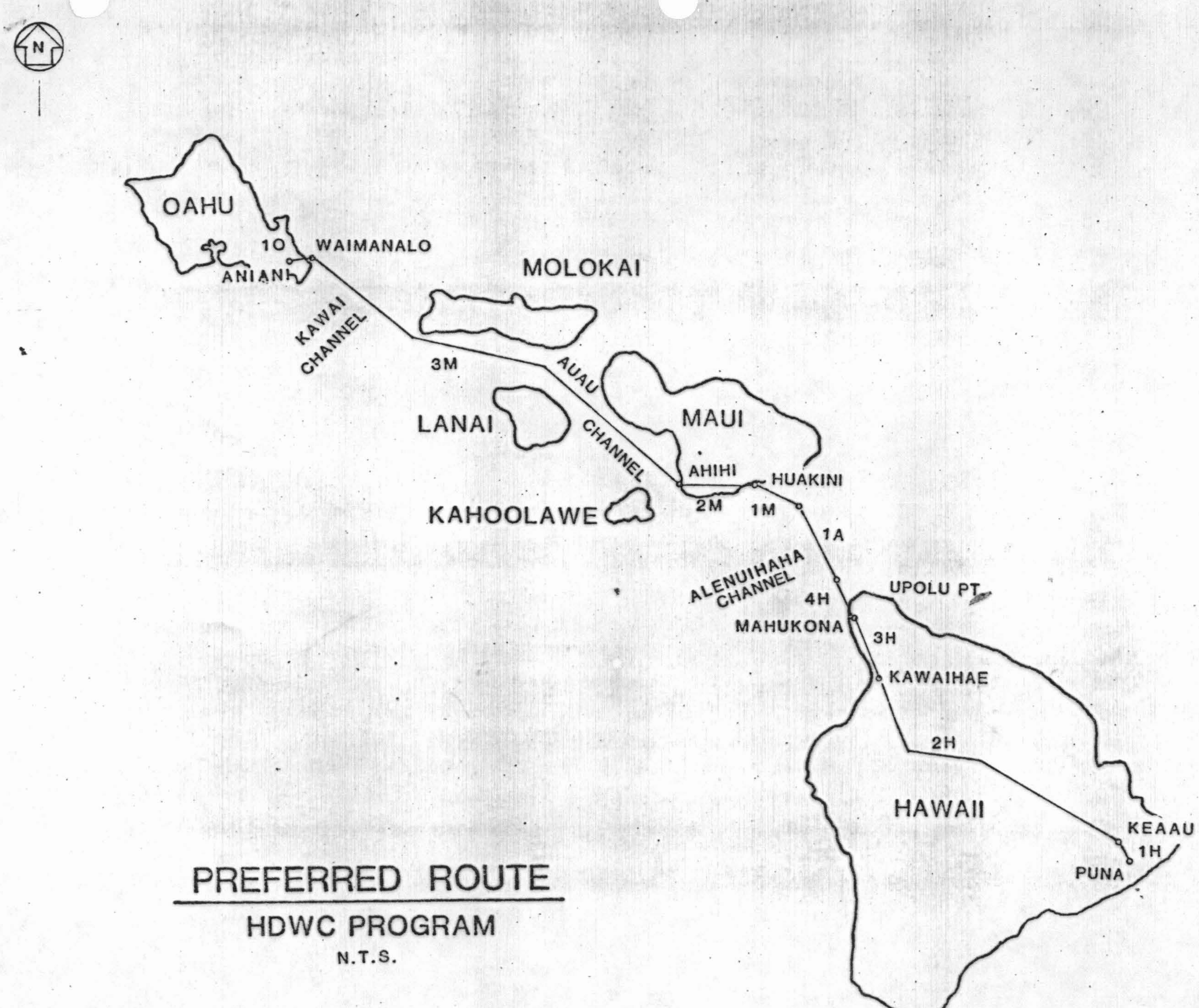

PREFERRED ROUTE

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N.T.S.

NOTE: FOR DISTANCE REFER TO PAGE 12.